DOCUMENT RESUME

ED 211 044 IR 009 841

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TITLE The PLATO PPTK System: An Alternative Keyboard Using the PLATO Computer-Based Education System for the Orthopedically Handicapped.
INSTITUTION Illinois Univ., Urbana. Computer-Based Education Research Lab.
PUB DATE 80
NOTE 50p.

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Accessibility (for Disabled); *Computer Assisted Instruction; Computer Graphics; *Input Output Devices; *Physical Disabilities; Physical Mobility
IDENTIFIERS *PLATO

ABSTRACT

Developed in response to the complex problems involved in providing equal educational opportunities for the intellectually alert orthopedically handicapped, the PLATO Programmable Terminal Keyset (PPTK) system makes the resources of PLATO compatible to the functional problems of a wide range of orthopedic conditions. This report describes the operational characteristics of the system, as well as the versatile range of applications for providing a high quality educational opportunity for severely orthopedically handicapped students. Nine references are listed. (LLS)

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The PLATO® PPTK System
An Alternative Keyboard
using the PLATO Computer-based Education System
for the Orthopedically Handicapped

William J. Goodman

Computer-based Education Research Laboratory
University of Illinois

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I. Foreword

To accurately portray the capabilities of PLATO, a few words are appropriate regarding technologies used in the creation of this report. All of the 75 character space typed pages, including the one you are presently reading, were originally typed into the computer memory of the PLATO System. The text was than copied from a PLATO terminal using a high speed document printer which had been connected to the terminal.

Figures 2 and 5 through 26 were developed using the graphics editor of the PLATO System. They were then transferred onto paper by using a graphics copier. The type used at the Computer-Based Education Research Laboratory (CERL), can be described as a "photographic" copier. The copier accurately reflects every detail viewed onthe terminal screen. This explains the difference between the characters produced by the document printer and the formation of text characters generated by the graphics editor. Figure 1 is a hand penciled drawing, and Figures 3 and 4 were made by a camera.

II. KEY WORDS

Adaptive Testing,
CAI,
CBI,
Communications Impaired,
Computer Testing
Direct Selection Device,
Interactive Communication,
Mainstreaming,
Non-Vocal,
Orthopedically Handicapped,
Scanning Device,
Special Education

III. Acknowledgements

Deep appreciation is expressed to Professor Donald L. Bitzer, Director of the Computer-based Education Research Laboratory at the University of Illinois, for his considerable support of my program within the department. I am also very grateful to Mike Hightower, for his selfless contributions in the development of the PPTK software.

All of the research and developmental work for this project was done at the Computer-based Education Research Laboratory without the benefit of any specific governmental or corporate research grants. The internal financing of this research and development by the University of Illinois thus represents a genuine commitment to education.

I am also greatly indebted to Julie Garrard, as well as Elaine Avner and Al Avner for their critically constructive editorial support. In addition I extend my appreciation to Wayne Wilson for his hand penciled drawing of Figure 1.

For their contributions to this report, I wish to thank Harper & Row Publishers, Inc. of New York for granting permission to quote from page one of Frank Wachowiak's book Emphasis Art, Third Edition, 1977. Recognition is also accorded Bruce Carter for his accurate illustration of the standard PLATO keyboard. This illustration was copied from his CERL PLATO lesson titled, "help".

William J. Goodman

Handicap Technology Program
PLATO Education Group
Computer-based Education Research Laboratory

IV. Words From the Past

One of the greater satisfactions of life a person can have, is to creatively compens.te for what he or she is otherwise unable to accomplish...

This introspective insight was brought to my conscious level as the result of my direct participation in a course for creative continuity writing in 1967. The immediate assignment required each member of the class to write a composite description, using clear and concise language, about themselves. The class instructor wrote verbatim my impressions of what was and still remains necessary to maintain dignity within a world inclined to label me "handicapped". Mrs. Carolyn Watts was the class instructor at the time I was enrolled in the Radio and Television Department of the College Conservatory of Music at the University of Cincinnati.

V. Abstract

Since 1960, PLATO, pioneered and developed by the Computer-Based Education Research Laboratory (CERL) at the University of Illinois, has become recognized as a well respected interactive computer-based education system. During these many years, PLATO has proved its effectiveness as an aid in learning for thousands of students from elementary school through college. The CERL PLATO system has grown in size to currently encompass 23 continental states, plus Hawaii and Sweden.

However, for many severely physically handicapped children and adults, effective interaction with any established educational system, institution, or process, including PLATO technology, has always been very difficult. The PLATO Programmable Terminal Keyset is in response to the complex problem of providing equal educational opportunities for the intellectually alert orthopedically handicapped. This report describes not only the operational characteristics of the PPTK system, but also its versatile range of application towards providing a high-quality educational opportunity for severely orthopedically handicapped students.

The PPTK system is a recent and unique technological development by which PLATO's versatile resources have been made compatible to the functional problems of an infinite range of orthopedic conditions. If a PLATO V terminal, a CDC/IST-1 or IST-2 terminal is to be used, then the PPTK technology is relatively inexpensive.

VI. Preface

Since 1960, PLATO, pioneered and developed by the Computer-Based Education Research Laboratory (CERL) at the University of Illinois, has become recognized as a well respected interactive computer-based education system. During these many years, PLATO has proved its effectiveness as an aid in learning for thousands of students from elementary school through college. The CERL PLATO system has grown in size to currently encompass 23 continental states, plus Hawaii and Sweden.

However, for many severely physically handicapped children and adults, effective interaction with any established educational system, institution, or process, including PLATO technology, has always been very difficult.

This project responds to the complex problem of providing equal educational opportunities for the intellectually alert orthopedically handicapped by developing the technology to support reasonable communications. To accomplish this goal, it was decided to capitalize on the existing technology inherent within the PLATO V, as well as the CDC/IST-1 and IST-2 terminals. The IST terminals are manufactured by the Control Data Corporation. An IST-1 terminal requires installation of random access memory at least 8 K words. An optional input-output card is also required.

By utilizing the microprocessing capabilities of these three terminal types, it became possible not only to resolve the complex educational and interactive communications problems of the orthopedically handicapped, but also to eliminate the staggering costs associated with specialized communications devices. Not only can PLATO's PPTK system facilitate education and enhance the interactive communications skills of this handicapped population, but it can accomplish its unique tasks without any inconvenience to the non-handicapped user of the PLATO terminal.

The contents of this manual will be of interest to three groups in particular: 1) educators who are struggling to provide an educational experience equal to the intellectual capacity of their orthopedically handicapped students; 2) parents who understand the relationship between successful self-determination and a solid and valid educational experience and who are seeking effective educational alternatives; and 3) students who are presently unable to use the paper-and-pencil methods traditionally used in the educational process.

In context of this report, the term "orthopedic" has a broad range of functional application. The words "orthopedic handicap" are not meant to describe a specific medical condition. Therefore, the report does not address itself to the countless specific causes of the orthopedic condition, but rather focuses on resolving the functional and educational problems of being orthopedically handicapped.

Unlike any of the manufactured specialized communications and/or educational devices intended to assist the orthopedic person with his or her interactive needs, PLATO's PPTK system offers a unique advancement in engineering design. The entire PPTK system is compatible with the broad range of physical abilities through the combined ability to custom select switches to be used for the Switch Assembly Unit, SAU, coupled with the flexible advantage that allows each person to determine the optimum location of each switch. This design feature enables the PPTK system to complement the unique physical abilities of each individual.

This report also refutes the popular usage of the word, "limitation", and its often stereotyping application to describe people who are orthopedically or otherwise physically handicapped. However, it does acknowledge that a limitation has real meaning for those whose attitudes commit them to a myopic view of the familiar and who are therefore afraid to explore the unknown.

VII. PLATO, the PPTK System, and Handicapped Students

The Nature of the Problem

Throughout the evolution of world civilizations, the "handicapped" have been assigned the least significant social role. A major factor contributing to the legitimacy of this adverse social condition was technology. The technologies implemented in the past, especially during the industrial revolution, placed emphasis on physical strength or clever manipulation rather than intellectual ability. We now look to the technological revolution to provide a means for the orthopedically handicapped to assert themselves responsibly and effectively and to contribute to the mainstream of American enterprise, technology, and culture.

The American educational system is obligated under the mandates of Public Law 94-142 (Title V, Sec. 504 of the Rehabilitation Act of 1973) to provide a valid educational experience for handicapped students. This difficult responsibility has caught educators at all levels unprepared to effectively develop the skills necessary for the rich intellectual growth of orthopedically handicapped students.

Parents, on the other hand, justifiably view the promise of PL. 94-142 as their child's constitutionally guaranteed right to future self-determination, predicated upon a solid educational experience that is truly equal to that of their able-bodied peers. Parents realize that their orthopedically handicapped children can benefit from a richly diversified educational experience, and as a result their children will have greater opportunities for becoming responsibly self-supporting. Under the banner of Public Law 94-142 why should these parents and their children expect anything less?

Federal legislation alone will not resolve the present dilemma of the American educational system. Neither will the installation of ramps, the use of wheelchairs, nor a healthy attitudinal perspective even begin to address the problem at its central core, although together they will significantly contribute to the process of integration and socialization.

Because of the technological advancement of the PPTK, the CERL PLATO system is a unique position to facilitate the student's intellectual ability to exploit the opportunities of a quality educational experience. The time-honored utilization of inappropriate paper and pencil technology need no longer be a barrier to the process of learning for the orthopedically limited student. The core of the problem for the orthopedically handicapped student is the inability to express his or her ideas on paper either in written form or pencil drawings. The barrier of paper and pencil technology must and can be overcome by developing effective versatile and affordable communication/education devices.

PLATO offers the alternative technology needed to make this dream a current reality.

The PPTK system

PPTK is an acronym for PLATO Programmable Terminal Keyboard. The PPTK system consists of two interdependent elements: (1) the PPTK computer program which replaces the PLATO keyboard, and (2) the Switch Assembly Unit (SAU), a customized switching unit that is used to control the PPTK. The PPTK program and the SAU make PLATO much easier to operate for people who are unable to use the standard keyboard because they have little or no functional use of their fingers, hands, and/or arms.

Figure 1 illustrates a PLATO terminal with the PPTK system. The PPTK system enables the student to interact with the computer. The PPTK program generates a screen display which serves as the functional equivalent to the standard keyboard. In this example the student controls the PPTK program by pressing buttons on the SAU. The SAU requires no physical modification to the terminal; it simply plugs into a socket located at the back of the terminal. The SAU shown in Figure 1, page 10, is only one of many possible physical arrangements. Operation of the PPTK system is described in detail in section VI: "Operating the PPTK System".

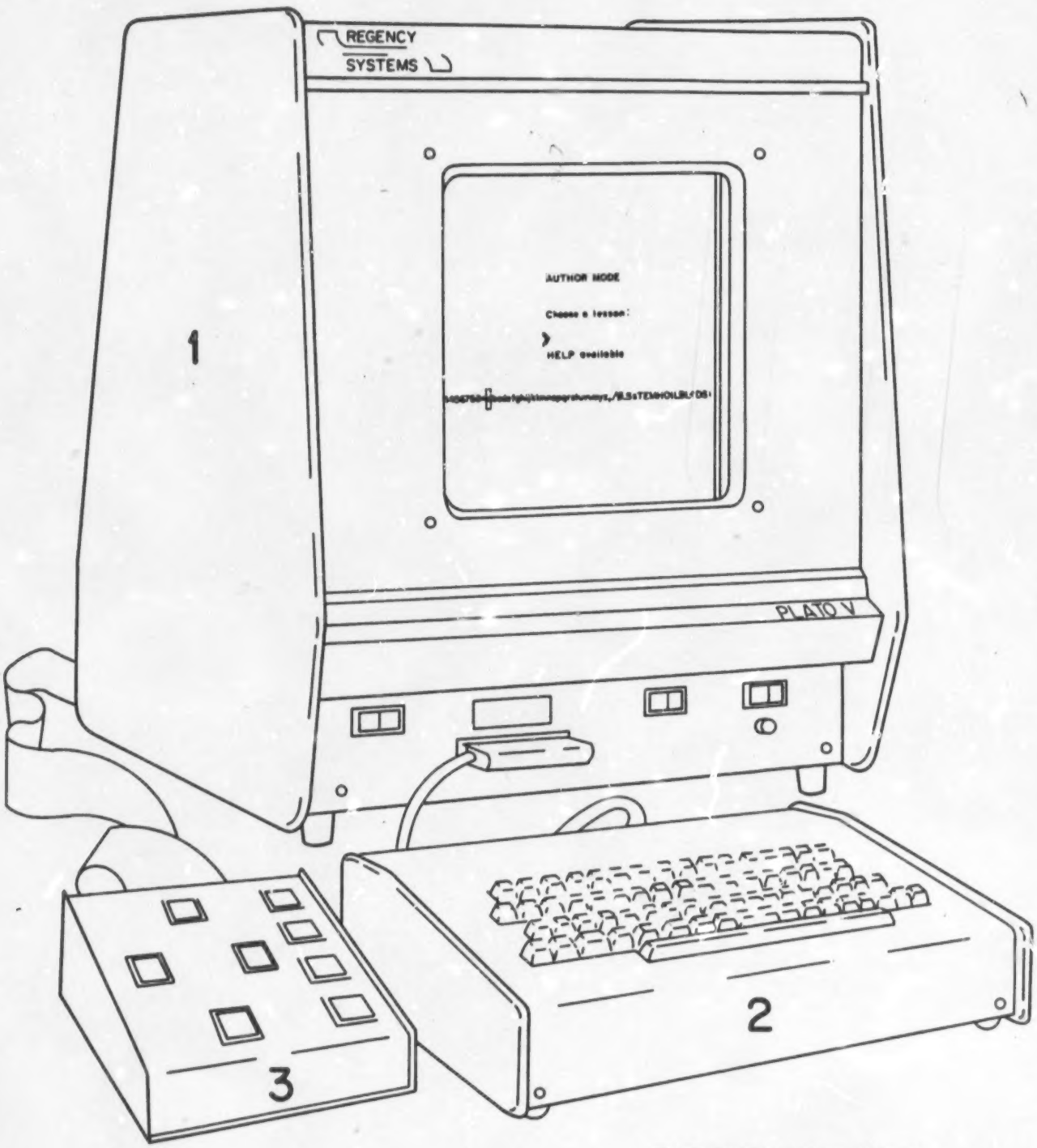


FIGURE 1

THE PPTK KEYBOARD DISPLAY IS ON THE TERMINAL SCREEN

1. PLATO V TERMINAL
2. STANDARD PLATO V KEYBOARD
3. SWITCH ASSEMBLY UNIT

Uses of the PPTK system

PLATO educational technology can help handicapped students participate more effectively in the dynamics of classroom education. It can facilitate the mainstreaming of severely physically handicapped students who may also have acute communications disorders affecting speech and/or the ability to write.

The PPTK system can be used to expand educational opportunities for physically handicapped students in two ways. First, it enables the student to use PLATO lesson materials to supplement and complement classroom instruction. Second, and more important, the PPTK system enables the student to use PLATO as a text-editing typewriter, thus allowing him or her to take notes, write papers, and create drawings with unaccustomed ease.

Use of the PPTK greatly increases the number of persons who can benefit from the wealth of instructonal material available on the PLATO computer-based education system. Lessons currently available are divided into 150 major areas of study covering topics as diverse as Accountancy, Chinese language, Law, Math, Music, Reading and Veterinary Medicine. Several thousand lessons also exist in additional fields, (Lyman & Postlewait, 1980); (Smith & Sherwood, 1976).

The PPTK system can also be effectively employed as a text-editing typewriter while connected to any PLATO terminal. As the student enters text (class notes, exams, etc.), it is displayed on the terminal screen. The text is stored in the computer's memory and can be re-displayed or edited at any time. The text can also be printed on paper by using a typewriter-like automatic printer which can be interfaced with the PLATO terminal. For example, the original manuscript of this report was composed and printed on the University of Illinois PLATO system. Every drawing appearing in this publication has been drawn by the author and copied from the CERL PLATO system using a graphics copier, with the exception of the hand drawing of Figure 1. The PPTK system can also be used to construct simple drawings or very complex graphics with typed text without any knowledge of computer programming. The capabilities provided by the PPTK system along with the PLATO system will reduce frustrations for orthopedically handicapped students.

Most-Restrictive Environment

The development of a strong and well-rounded intellect often is the result of the individual's inititive and ability to control and expand his or her physical and educational environment. The student's handicap may be so acute that it adversely affects the ability to function independently.

The physical handicap may require confinement of the student to his or her family home, hospital, or other long-term care institution, and therefore could make the legal promise of a "least restrictive environment" impossible to consider. However, PLATO's ever expanding instructional resources, as well as its word processing and graphics capabilities, is able to meet most of the educational requirements of students who happen to be severely orthopedically handicapped.

The necessity to place the student in a "most-restrictive environment" need not be considered a fatal termination to the educational and intellectual growth of the convalescing student. The instructional programs available on PLATO can help the teacher or tutor with the task of facilitating the student's intellectual and educational growth. SYS III, a computerized instructional system, provides a catalog of basic skills lessons which have been reviewed for content, clarity, and level. It also provides a flexible system for prescribing individualized assignments, as well as computer-managed instruction (CMI) curricula in reading comprehension, language, and mathematics. SYS III also automatically maintains records that reflect the progress of each student. This information is available to the instructor at any time. The teacher has the right to request that specific instructional lesson be added to SYS III. In the event the instructional material does not exist, the Handicap Technology Program will work with subject/content experts to develop the PLATO lesson.

In addition to offering a wide range of materials, there are instructional advantages to learning from a combuter-based system such as PLATO. A recent article published in the Journal of Computer-Based Instruction, (Avner, Moore, & Smith, 1980), offers evidence in support of the idea that active cognitive processing of information can be better assured with computer instruction than with traditional methods of teaching. As is well documented in the learning research literature, active cognitive processing leads to superior learning and retention, (Bugelski, 1977).

The utilization of PLATO's capabilities in the setting of a more restrictive environment can provide a new dimension to mainstreaming. Where it is not physically feasible to place the student in a less restrictive environmental setting, PLATO has the capability to allow access to the challenging world of quality academic education even in the most restrictive setting.

However, it is not the intent of the author to suggest in any way that PLATO's versatility and wealth of educational material can provide all of the answers to an inquisitive mind that is continually isolated by a physically restrictive environment. It is not enough just to be academically qualified. To survive on an "equal opportunity" basis students must learn to interact effectively socially with their able-bodied peers and must acquire survival skills that will prepare them for their place in the competitive reality of the adult world. These are the basic

tenets that form the foundation of the concept of least-restrictive environment, commonly known as mainstreaming.

It is essential that educators, parents, and students know their respective rights and responsibilities in the development of a well conceived IEP (Indiviualized Education Program). It is through the IEP that quality input results in a superior educational experience for orthopedically handicapped students.

VIII. Overview of the PPTK System

As has been noted the PPTK system consists of two interdependent elements: (1) the PPTK computer program which replaces the PLATO keyboard; and (2) the Switch Assembly Unit (SAU), which is a customized switching unit that is used to control the PPTK.

PPTK Keyboard

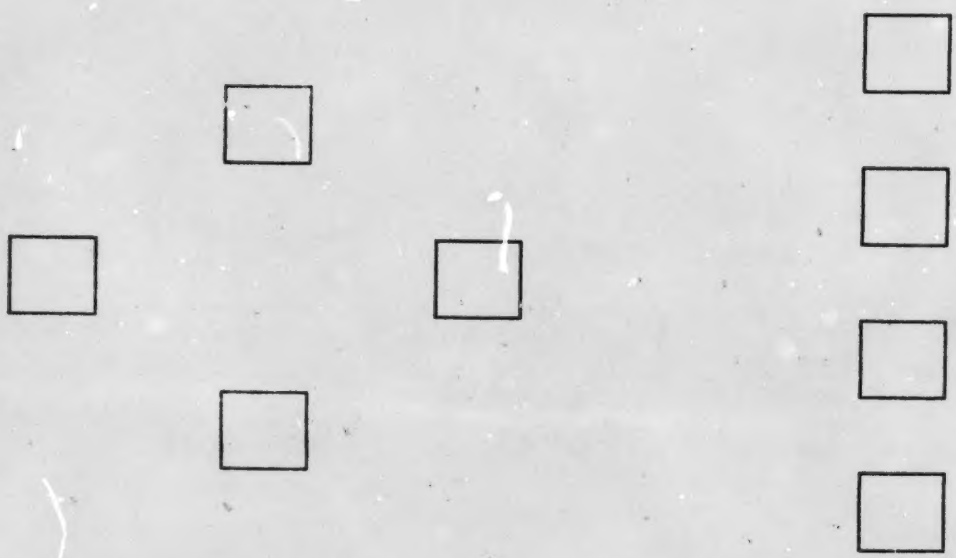
Although the PPTK computer program is the functional equivalent of the conventional PLATO keyboard, its operation is radically different. Unlike the accustomed operation of a typewriter or computer keyboard, where the selection of each alphanumeric and control key is accomplished with one strike of a finger, the selection of each alphanumeric and control key is done with the aid of a horizontal scanning light called the key selector. This light is superimposed over the single-line display as it glides over the character string. Each character of the string represents an alphanumeric or control key found on any PLATO keyboard. The user controls the movement of the light by manipulating two SAU switches. The key selector is stopped and superimposed on the desired key, and the input switch is than pressed sending that key to the central computer. The PPTK system also provides direct selection capabilities for students who cannot physically reach and touch the terminal screen, thus permitting access to the hundreds of PLATO lessons that require direct selection.

PPTK is an acronym for PLATO Programmable Terminal Keyboard. The PPTK system consists of two interdependent elements: (1) the PPTK computer program, which replaces the PLATO keyboard; and (2) the Switch Assembly Unit (SAU), a customized switching unit that is used to control the PPTK. The PPTK system is very safe to use because the microprocessor delivers only 3.5 to 5 volts at 1 milliamp to any one of the eight switches comprising the SAU. The PPTK program and the SAU make PLATO much easier to operate for people who are unable to use the standard keyboard because they have little or no functional use of their fingers, hands, and/or arms.

SAU

Figure 2 shows the two elements of the PPTK system. The horizontal line of characters at the bottom is a copy of the PPTK keyboard display, which is a substitute for the standard PLATO keyboard. Above the single-line keyboard display are eight squares. These squares symbolize the eight switches of the SAU which are manipulated to make this substitute keyboard work. Keep in mind that the eight squares used in this report do not appear on the terminal screen. Also the symbols representing the SAU were modeled on the unit shown in the bottom half of Figure 3. Figure 3 illustrates two versions or models of the SAU. Recent developments in the technology of human engineering make it possible to custom design switch assembly units that are able to resolve every functional problem for any orthopedic condition.

The SAU of the PPTK system is versatile enough to permit the use of any desired type of switch. The SAU does not require any physical modification of the terminal; it plugs directly into the microprocessor port located at the rear of the terminal. The switches making up the SAU are mechanically as well as electrically discrete. Infinite possibilities therefore exist for custom arrangement of these switches to make it feasible to operate the PPTK alternative keyboard with any part, or parts, of the body. The SAU is the most critical component of the PPTK system. Therefore, care must be exercised in the selection of switches to meet the specific needs of each individual. Only in this way can the PPTK system successfully adapt to the extreme variations of manually handicapping conditions.



→+←-÷×Ø123456789= abcdefghijklmnopqrstuvwxyz,./; _SsTEMHOIBL↑DS2

Figure 2. PPTK system

Figure 2 illustrates the PPTK line display along with the eight squares that represent one of the many possible configurations for the SAU.

The following pictures illustrate a few of the infinite number of possible physical configurations of the SAU. As a result of custom designing of each switch assembly unit, the PPTK is made compatable with an extremely wide range of orthopedic conditions.

Figure 3. The student facing the terminal screen.

Notice that this unique configuration of the SAU allows the individual to maintain constant visual contact with the activity on the screen display. Thus, the orthopedically handicapped student's mental concentration is not disturbed, as it may be when attempting to use the conventional keyboard.

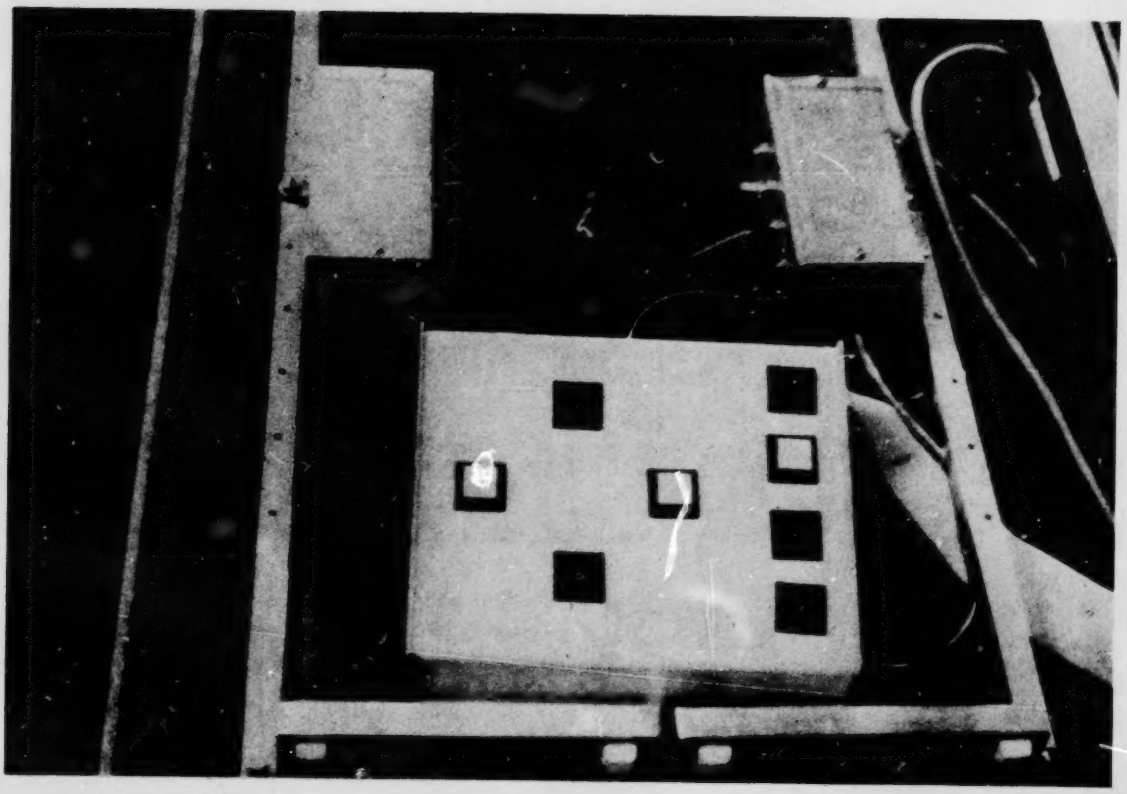
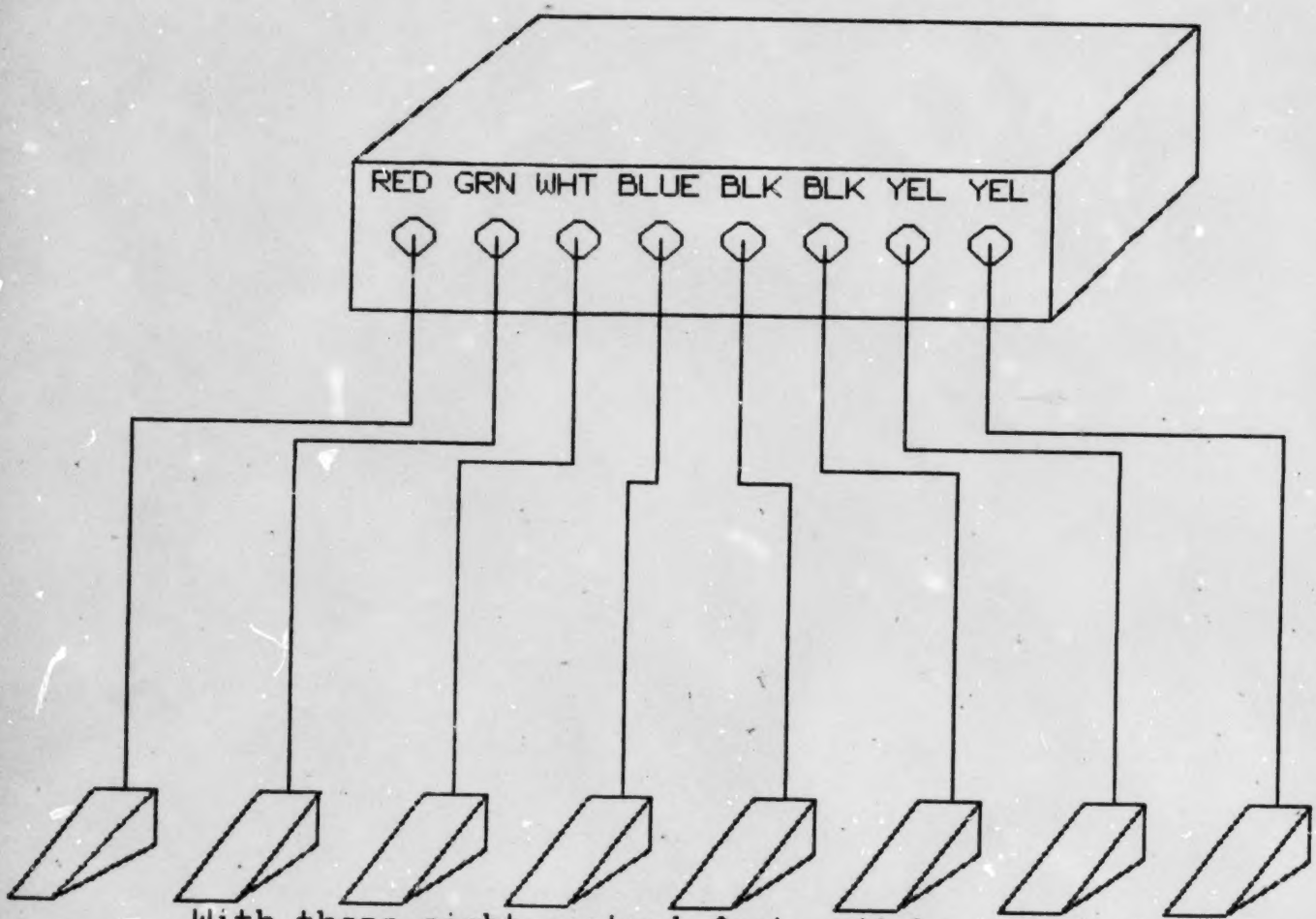


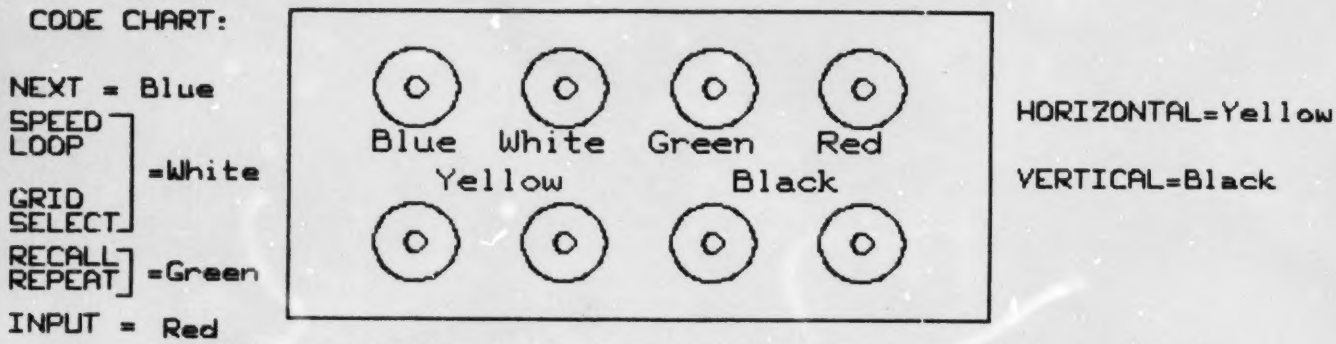
Figure 4 Many possible configurations

This picture illustrates two of the many possible configurations for the SAU technology. Even though the two different units do not appear to resemble each other physically, they are electrically identical; therefore, they perform exactly the same functions.



With these eight control foot switches coupled through the switch assembly unit, the PPTK user will be able to effectively express his or her ideas whether it involves lesson usage, text or graphics editing. This particular switching assembly uses readily available foot control switches.

Figure 5.
PLATO screen drawing of a foot-switch form of the SAU.



This switching configuration is intended to illustrate proximity type switches that respond to finger proximity rather than finger pressure. The range of motion of each individual will determine the physical position of each switch.

Proximity switches are useful devices for those who are unable to apply physical pressure to any other type of switching mechanism. To expedite identification of respective functions for the eight switches comprising the SAU, it is suggested that color coding be assigned to each switch. The proposed color scheme would be: NEXT=Blue; SPEED LOOP/TOUCH SPEED CONTROL=White; PPTK RECALL/REPEAT MODE=Green; INPUT=Red. Both of the horizontal switches have been assigned the color of Yellow. The two remaining vertical switches are Black. In order to minimize informational clutter, the first initial of each color will represent its associated color throughout this report.

Figure 6.
PLATO screen drawing of a proximity form of the SAU.

For information about a custom designed Switch Assembly Unit, contact: William J. Goodman, Handicap Technology Program, 252 Computer-based Education Research Laboratory, 103 S. Mathews Avenue, University of Illinois, Urbana, Illinois 61801.

IX. Operating the PPTK System

Initiating the PPTK

To initiate the PPTK, simply type pptk on the AUTHOR MODE page. Then press the DATA key on the standard keyboard. Once this has been done, it takes about 15 seconds for the machine language program to be "loaded" into the microprocessor within the PLATO terminal. After the PPTK program has been loaded into the terminal, the microprocessor retains it until either the reset switch has been pressed, or the terminal power has been turned off. If the student signs off the PLATO system but does not turn the terminal off, or has not pushed the reset switch, the PPTK system remains active and the next user can sign on without having to reinitiate the PPTK program.

The SAU Switches

NEXT

The SAU switch labeled NEXT directly corresponds to the function of the NEXT control key on the standard PLATO keyboard. The NEXT key is pressed when you want to advance to the next screen display in most PLATO lessons. Pressing the NEXT key is analogous to turning a page in a book.

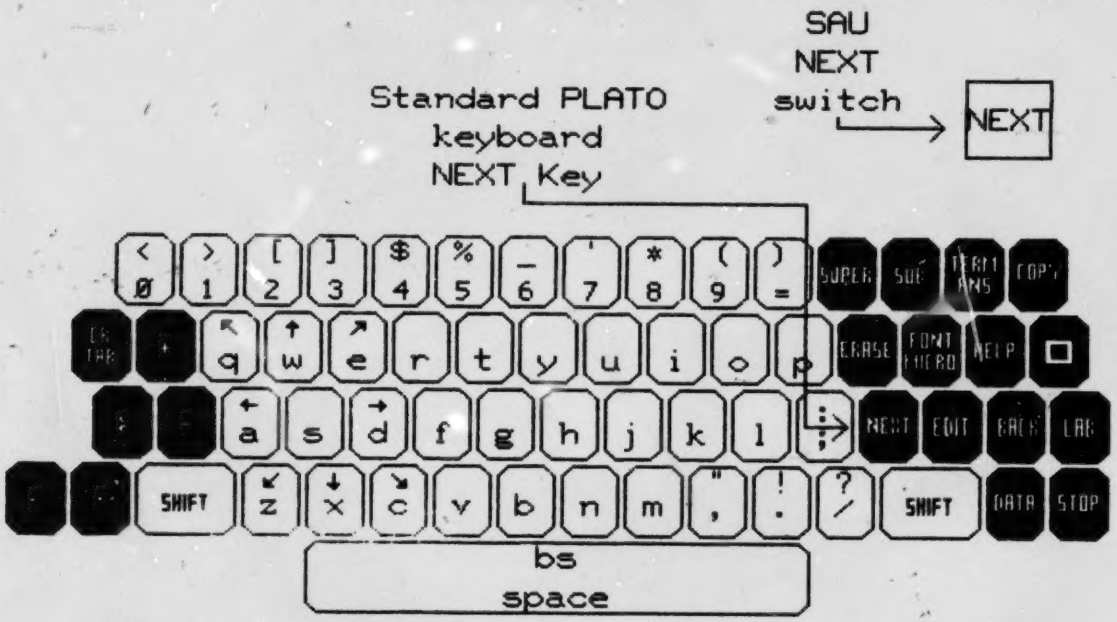


Figure 7.
Correspondence of the "NEXT" key on keyboard and SAU.

Illustration of the standard PLATO keyboard.
Courtesy of: Bruce Carter, Indiana University

Horizontal Switches

The remaining seven switches of the SAU are labeled to identify their respective functions. The two switches labeled "⇦" and "⇨" control the lateral movement of the key selector. Sustained pressure on either of the two horizontal switches will force the key selector beyond the extreme ends of the keyboard display and result in the key selector quickly returning to the opposite end of the keyboard display. The reason for using the horizontal wrap-around capability of the key selector is to help increase the rate of speed for typed input.

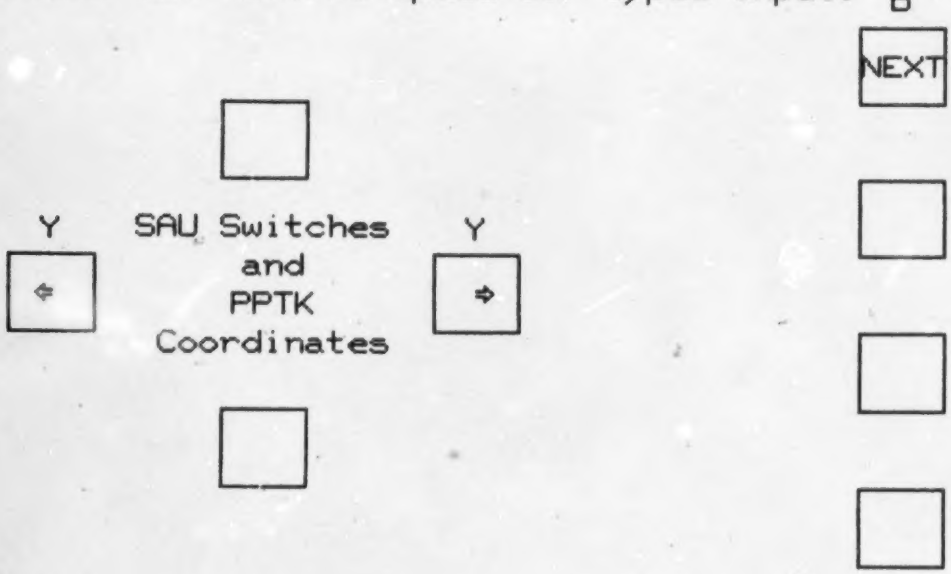


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Figure 8.
Horizontal Indexing Switches

Speed Loop

By pressing the switch labeled PPTK SPEED LOOP you can control the speed at which the key selector glides over the screen keyboard display. The SPEED LOOP switch adjusts the key selector speed to each individual's muscular and time requirements. There are four speeds from which to choose. The speed indicator is located at the far right end of the screen keyboard display. Presently it is on second speed.

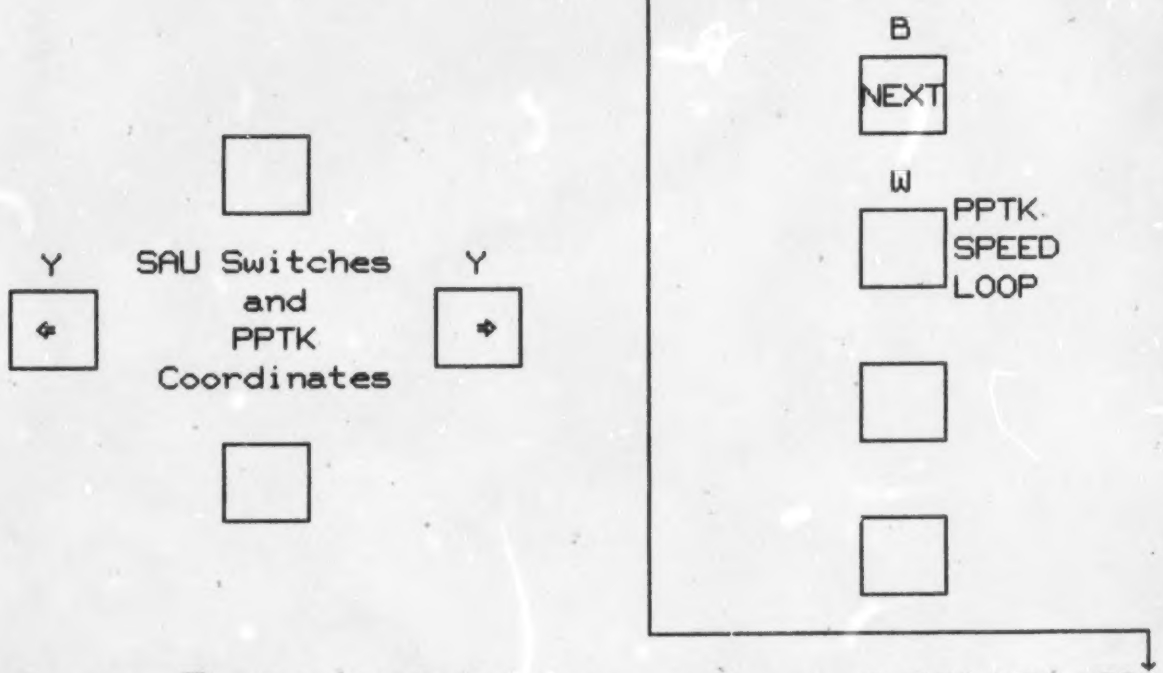

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Figure 9.
PPTK Speed Loop Switch

Vertical Switches

The switches identified with the vertical arrows "⇧" and "⇩" determine the line location for the entire PPTK screen display. These two switches give the ability to change the position of the PPTK to any vertical line location between the top and the bottom line of the terminal screen. More will be said about this feature in the sections under "Relative Line Positioning" and "Recovering Screen Text".

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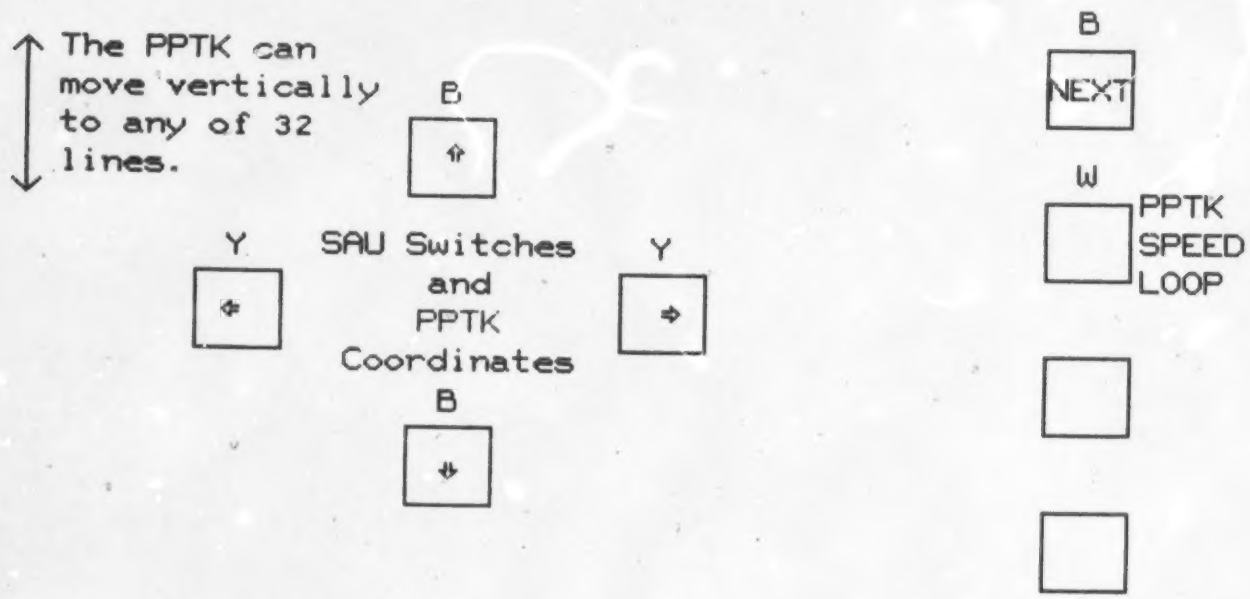


Figure 1Ø.
Vertical Control Switches

Input Switch

The process for determining the character for typed input requires controlling the horizontally scanning key selector. The previously mentioned SAU directs the key selector to move to the left or right through the activation of the left or right horizontal switch (see Figure 8). Releasing pressure on the horizontal switch immediately halts movement of the key selector. Once the scanner has selected one of the alphanumeric, punctuation, or control keys, the character is displayed on the terminal screen following the application of pressure to the INPUT switch. For example, the following steps are required to input the character "a":

(1) By pressing one of the horizontal switches move the key selector so that it is superimposed on the letter "a". To stop movement of the selector, release pressure on the horizontal switch.

(2) Press the INPUT switch.

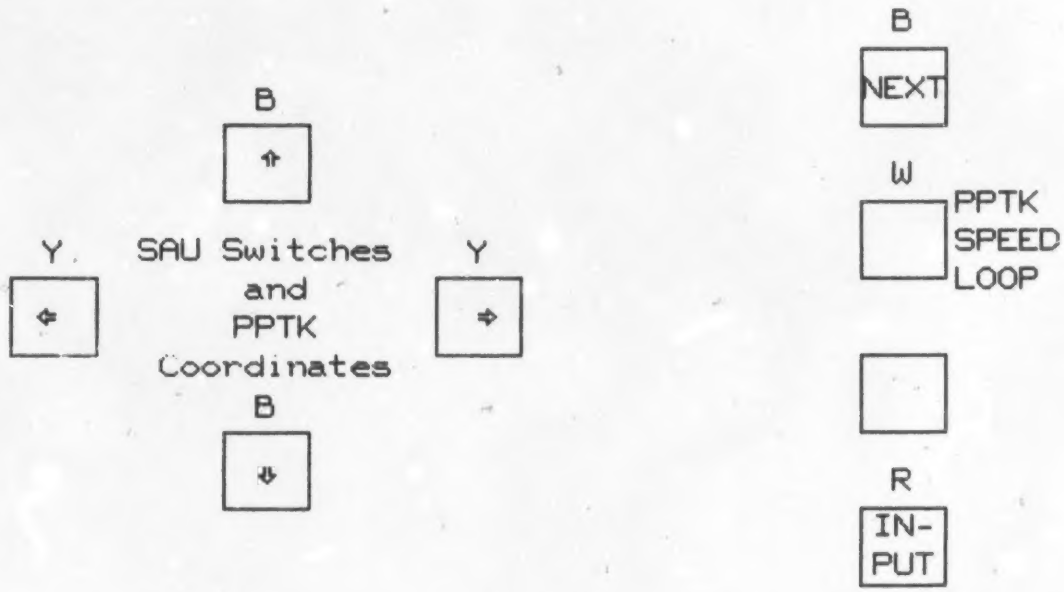
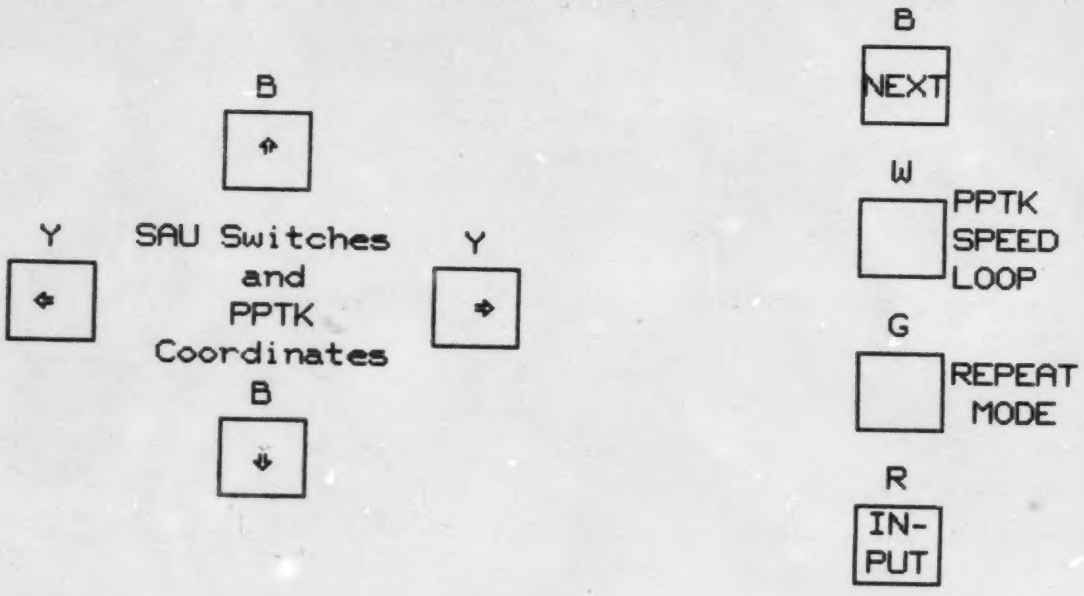


Figure 11.
Input Switch

Repeat Mode

Pressing the REPEAT MODE switch puts the PPTK system into automatic character generation. In other words, when the key selector is on the letter "a", or any other alphanumeric character, including punctuation characters, or certain control key symbols, that character or control key symbol will automatically repeat itself if pressure on the INPUT switch is not released. When the REPEAT MODE switch is pressed a second time, the PPTK will discontinue automatic character generation.



→+←-+×Ø123456789= bcdefghijklmnopqrstuvwxyz,./; _SsTEMHOIBL↑DS2

Figure 12.
Repeat Mode

Character Selection

Lower-Case / Upper-Case

So far we have been discussing the PPTK system without investigating the distinct differences between lower-case, or unshifted, characters and upper-case, or shifted, characters. As on a standard typewriter, the PPTK has two sets of characters: a lower-case set (unshifted) and an upper-case set (shifted). The shifted version of the PPTK can function as both normal shift and lock shift. The PPTK display shows the set of lower-case characters when in the unshifted version, and the upper-case characters when in the shifted version.

Though both versions of the PPTK are shown along with the standard PLATO keyboard, the actual PPTK keyboard display contains all of the lower-case and upper-case characters within the single line PPTK screen display. All of the lower-case characters are instantaneously transformed to upper-case after the shift arrow symbol "↑" has been identified by the key selector. This figure also shows the organizational similarities between the PPTK and the standard PLATO keyboard. The organizational arrangement of both lower-case and upper-case characters generally follow the same key format of the standard PLATO keyboard. From left to right are the arithmetic, alphanumeric, punctuation, spacebar, and control key symbols.

Figure 13.
A Functional Comparison

Shifted-Characters

By placing the key selector over the shift-character symbol "↑" and pressing INPUT once, you can see any shifted alphanumeric, punctuation, control key or backspace character. By pressing shift-INPUT once, only one shifted character will result. When two shifted INPUTs are made, successive shifted characters are possible. The third shifted INPUT returns the single line keyboard display to its initial lower-case status.

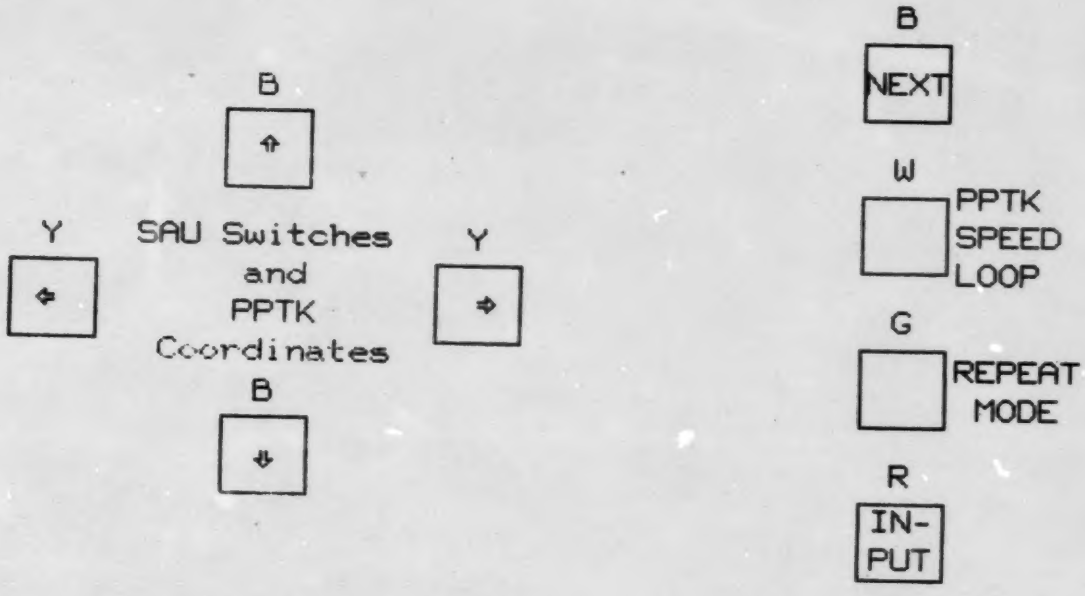


Figure 14.
Shifted Character Display

Arithmetic & Control Keys

Figure 15, Table A, illustrates the Arithmatic and Control Key symbols as they appear within the lower-case version of the screen display keyboard. Tables A and B show that there is a distinct difference between the unshifted and the shifted version of the PPTK. Note the difference between the characters shown in Table A and those shown in Table B.

Arithmetic & Control Keys			
→ = tab	× = multiply	E = erase	B = back
+ = plus	_ = space bar	M = micro/font	L = lab
⇕ = arrow	S = super	H = help	↑ = shift
- = minus	s = sub	O = square key	D = data
÷ = divide	T = term/ans	I = edit	S = stop

NOTE: Momentary Shift = 1 press on INPUT key.
Full-lock Shift = 2 presses on INPUT key. 3rd. = ↓
Square & Copy key functions are determined by the unshifted & shifted keys, as is too for micro/font.

Table A

→+⇕-÷×Ø123456789= abcdefghijklmnopqrstuvwxyz,./; _SsTEMHOIBL↑DS

Arithmetic & Control Keys			
← = CR	∪ = multiply	E = erase	B = back
Σ = plus	← = space bar	F = font/micro	L = lab
⇕ = arrow	S = super	H = help	↑ = shift
Δ = minus	s = sub	C = copy key	D = data
∩ = divide	T = term/ans	I = edit	S = stop

NOTE: Momentary Shift = 1 press on INPUT key.
Full-lock Shift = 2 presses on INPUT key. 3rd. = ↓
Copy & Square key functions are determined by the shifted & unshifted keys, as is too for font/micro.

Table B

←Σ⇕Δ∩∪<>[]$%_'*() ABCDEFGHIJKLMNOPQRSTUVWXYZ"!?: ←SsTEFHCIBL↑DS

Keyboard shifting is accomplished by placing the key selector over the shift arrow, as illustrated in Table B, and then pressing INPUT.

Figure 15.
Arithmetic & Control Keys

In Table B, Figure 15, on the extreme left end of the shifted version of the keyboard you will see five unfamiliar characters: ←,Σ,⇐,Δ,∩,∪, These characters are the shifted characters normally not visible on the standard PLATO keyboard buttons. Four of these "characters" are the shifted arithmetic keys. The " " symbol is my idea of what a shifted carriage return (CR) should look like. However, in reality the (CR) does not have a shifted symbol. Do not confuse the (CR) symbol with the shifted backspace symbol "←" appearing at the right end of the PPTK display.

Control Keys

As mentioned in Table A the "Square & Copy key functions are determined by the unshifted & shifted keys...". In other words, the Square Key is visible only when the PPTK is functioning as a unshifted keyboard. The Copy Key becomes operational only when the keyboard is shifted from lower to upper-case. The same operational characteristics are also evident for the Micro and Font Keys. When the keyboard is shifted from lower-case to upper-case, the Micro Key is replaced by the Font Key as indicated by Table B.

Table B makes note of the fact that "Momentary Shift = 1 press on INPUT key." This allows only one shifted character to be typed before the keyboard automatically returns to lower-case. A full-shift lock will result when the shift-INPUT keys are pressed twice. While the PPTK remains in the full-shift lock state, successive upper-case characters can be typed. To release the keyboard from full-shift lock state, you must press the shift-INPUT keys a third time. This will manually return the PPTK to lower-case.

Text editing and graphics flexibilty are possible even though the student never presses more than one of eight switches of the SAU at any time. Control key operations requiring multiple key presses per function, such as Shift-Super, Shift-Sub, Shift-Term/Ans, Shift-Copy, Shift-Erase, Shift-Help, Shift-Square, Shift-Next, Shift-Edit, Shift-Back, Shift-Lab, Shift-Data, and Shift-Stop. etc. are easily executed with the PPTK system.

No attempt will be made to explain the operational intricacies of any of the control keys in this report, except to say that generally control keys are useful in editing and drawing. It is assumed that users will consult lesson "aids", or the lesson "help" for a very complete discussion of the functions of the control keys. These lessons are available only on the PLATO computer system.

Digital Spacebar

The Digital Spacebar indicator registers up to nine spaces forward as well as up to nine backspaces. Placing the key selector on the spacebar symbol "_" and pressing INPUT enters a space. Initially the digital spacebar indicator registers "Ø". In the unshifted operation of the PPTK, the indicator counts each spacebar insertion by advancing from "Ø" through "9". To backspace, place the PPTK into shift-character. The indicator now will count in reverse, that is Ø,9,8, etc. The symbol for backspace is "←".

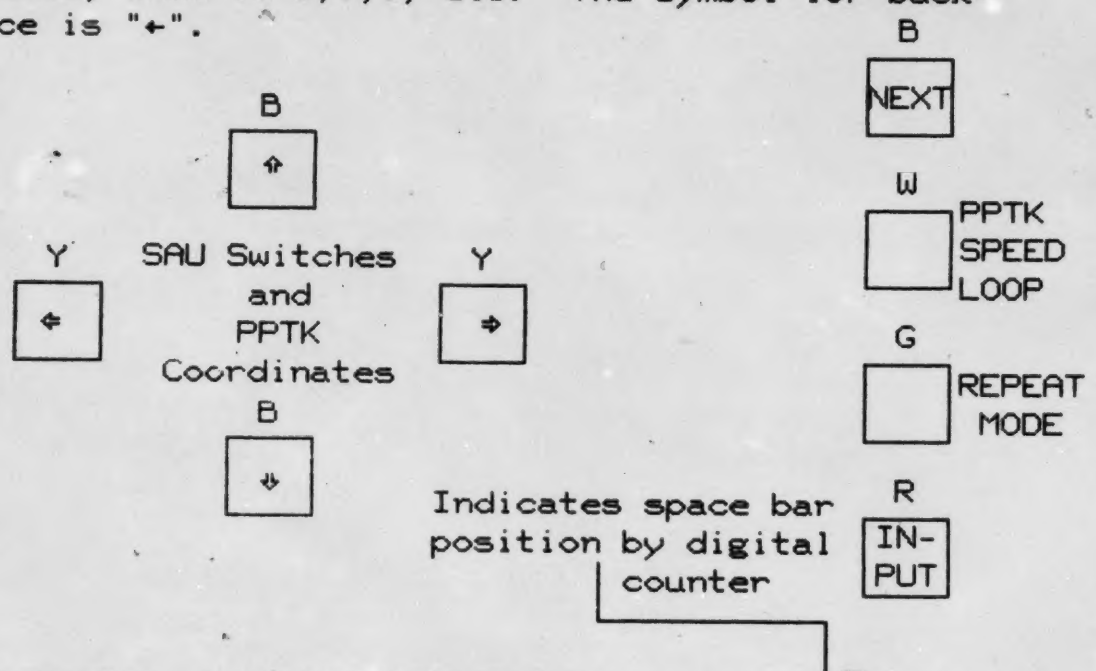


Figure 16.
Spacebar

Touch Input

Another dynamic feature of the PPTK technology is that it can simulate the touch-panel input for anyone who is unable to activate the terminal with a normal finger press on the terminal display screen. The touch panel is a device incorporated into all PLATO terminals which allows the student to indicate a response by "touching" the terminal screen rather than the keyboard. The process of touching the terminal screen enables the student to supplement use of the keyboard by directly touching specific areas of the terminal screen. This method of "communicating" with the terminal is known as touch input or direct selection. Touch input is an important consideration since there are hundreds of instructional lessons that require direct contact with the terminal screen in addition to the keyboard. For those individuals who possess the physical ability to use the standard PLATO keyboard but lack the strength or coordination to press their fingers against the touch-responsive screen, the PPTK and the standard keyboard can be employed simultaneously; the 64-button keyboard is used for typed input, while the PPTK provides for touch input.

Touch Cursor

While in lower-case, positioning the key selector over the area indicated by the "Touch Cursor Switch" and pressing INPUT will make the single-line keyboard disappear. In its place is the symbol "+". The + will appear in the center of the screen.

Movement of this Touch Cursor is controlled by the four "Cursor Switch Coordinate" switches. These four switches serve a dual role. In addition to being used for typed input, these switches govern the four directions that the Touch Cursor can move.

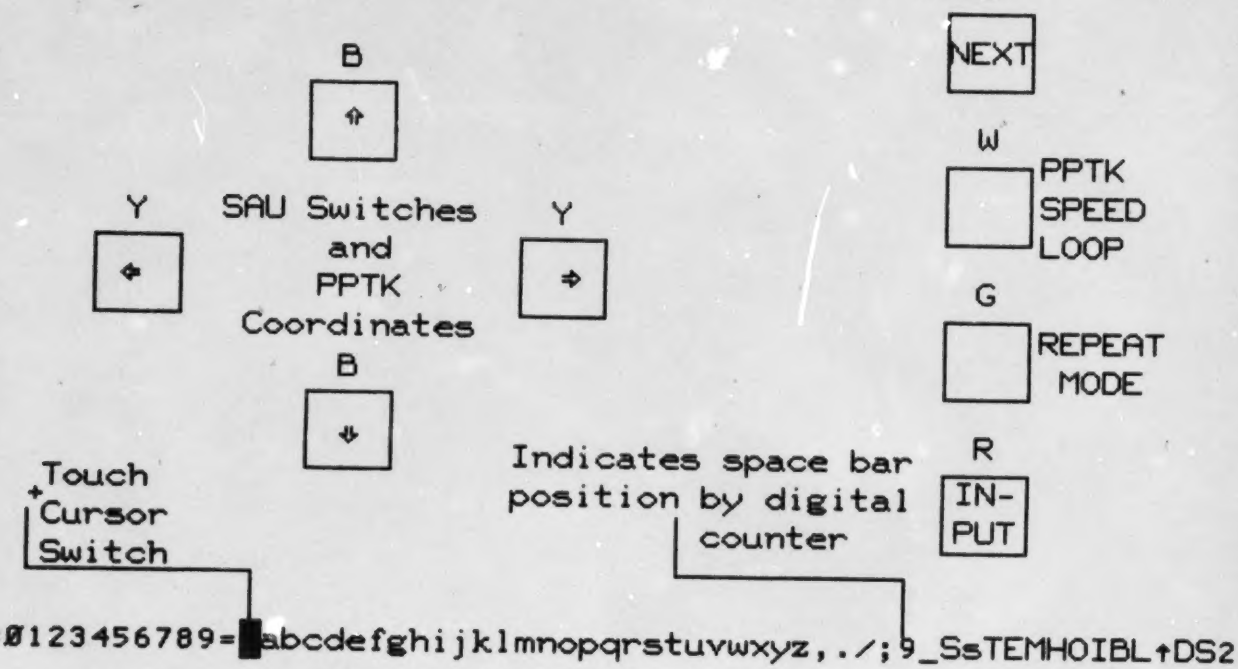


Figure 17.
Touch Cursor

The Touch Cursor has a range of four different speeds. The speed-control switch can adjust the touch input to each individual's muscular or time response needs. Pressing the TOUCH SPEED CONTROL switch will change the traveling speed of the Touch Cursor. In Touch Mode, the number in the lower right hand corner of the screen, either 1,2,3, or 4, indicates the speed in use. With each incremental rise of the the indicator digit, the traveling cursor increases in speed.

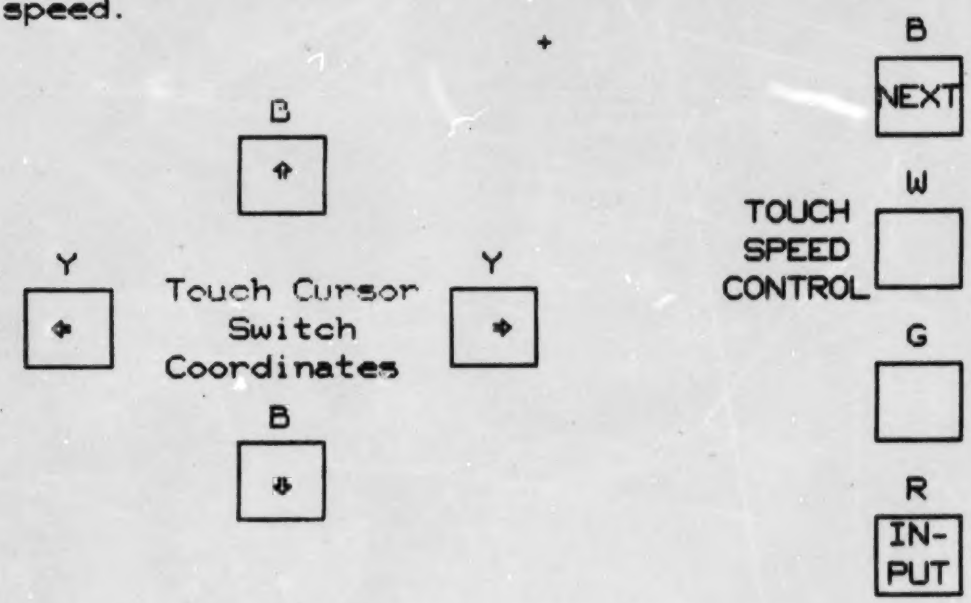


Figure 18.
Touch Speed Control

Recall

While the TOUCH SPEED CONTROL function is employed exclusively for Touch Mode, it shares the same switch that is used for the PPTK SPEED LOOP.

To use the Touch Mode, position the cursor over the area of the screen where you wish to register a touch response. For each successive Touch Input response, relocate the cursor and press INPUT.

To leave Touch Input Mode and reactivate Type Input Mode, press the PPTK RECALL switch.

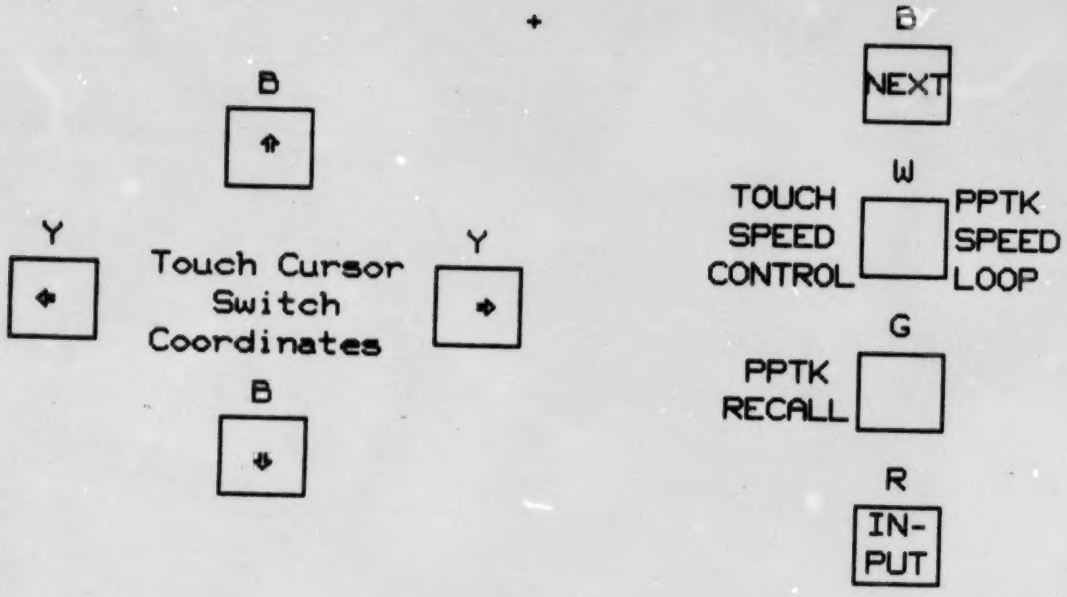


Figure 19.
PPTK Recall

Developing Text and Graphic Displays

Text

In addition to using PLATO as an interactive medium for instruction, orthopedically handicapped students would be at a definite advantage by learning how to exploit fully the existing text and graphics editing capabilities of PLATO. The advantage of using PLATO as a text editor is that it gives the student a time-saving ability to construct very detailed typed text composition. Unlike the complications associated with pencil, paper, and typewriter, the text editor enables the user to delete any text error, insert new wording, correct spelling, reorganize paragraph sequence, etc. The versatility of the text editor can be employed by the student to revise any specific portion of the text without rewriting the entire composition. The composition may be related to the fundamentals of education such as reading, writing, and arithmetic, to higher levels of discipline involving a broad range of subjects from the humanities to the "hard sciences". The editor is compatible with sciences such as physics and chemistry, because of its ability to execute scientific notation. After completion of word processing a document printer may be connected to the terminal for a rapid transfer onto 8.5"x11" paper of the stored computer text.

In order to use PLATO for typed text or graphics, each individual must be assigned a computer file. The computer file is memory that is allocated within the computer, and can be thought of as analogous to writing or drawing paper. The comparison of computer memory to paper is very simple. The capacity or ability of the computer to store information is affected by electronic circuitry design, while the informational capacity of any piece of paper is directly determined by the physical area of the paper.

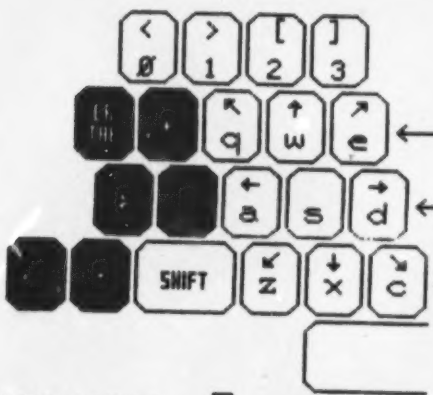
Information about how to use the text editor is contained within the assigned file space. This documentation is available by pressing the HELP key on the standard keyboard, or the "H" symbol of the control keys if the PPTK is being used.

Graphic Cursor Directive Keys

Either of the options "ID" or "SD", respectively "insert display" or "show display", will activate the graphics editor. For a clarification of the ID and SD options examine the documentation contained within the assigned PLATO computer editing file. Further information relating to graphics documentation is accessed by pressing the HELP key on the standard

keyboard, or the "H" symbol of the control keys if using the PPTK after pressing the lower-case characters: "id" (or) "sd". After entering the editing file either option will generate a graphics cursor on the terminal screen. Graphic displays are created by moving the cursor appearing on the screen to form line drawings. The cursor is moved by selecting one of the cursor directive keys. The eight directive keys that govern the compass-like movements of the graphics cursor are marked with arrows on the standard PLATO keyboard. See Figure 20.

With the standard keyboard, movement of the graphics cursor is accomplished by manually pressing one of the eight directive keys for each incremental movement of the cursor. Each key press moves the cursor one increment in the direction indicated by the arrow on the key. Do not confuse the graphics editing cursor with the previously discussed cursor used for touch input. The two cursor types have their distinctly different functions.



Key press:

e = move cursor, Northeast

d = move cursor, East

c = move cursor, Southeast

etc.

→+✥-+×Ø123456789= abcdefghijklmnopqrstuvwxyz,./; _SsTEMHOIBL↑DS

Although the PPTK screen display keyboard does not show the convenient compass arrow markings, selecting and inputting the lower-case characters listed in the figure above will result in movement of the cursor in the indicated direction.

Figure 2Ø.
Graphic Cursor Keys

The linear direction of the moving graphics cursor may be controlled by activating the REPEAT MODE switch before maintaining pressure on the INPUT switch rather than manually tracking it with repeated activation of the INPUT switch for each incremental movement of the cursor.

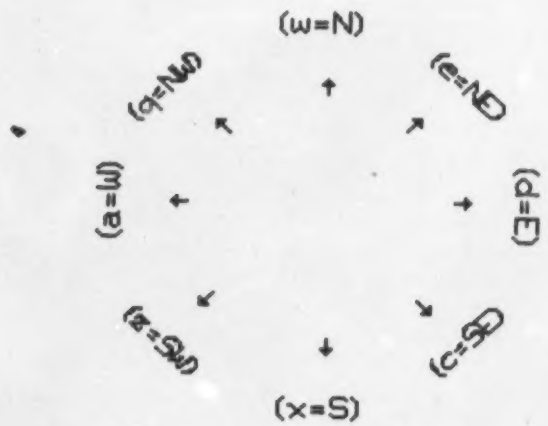


Figure 21. may be a helpful reference when using the PPTK system during the process of creating graphics. It shows the eight directions that the graphics cursor can move, as well as giving the alpha character associated with each arrow key. To move the cursor, it is necessary to (1) select the arrow key, (2) then press INPUT.

Figure 21.
Repeat Mode

Graphics and Text Combined

"Their imagination and inventiveness know no bounds; their designs and configurations are excitingly unpredictable."..."To observe children develop in drawing, painting, and constructing skills, to see them grow from year to year in their artistic expression, is to witness a most fascinating aspect of human individual growth". (Wachowiak, 1977).

In his book Emphasis Art, Frank Wachowiak addresses the developmental needs of children that can be met through the many media of art. Within context of the publication it is natural to make assumptions about the physical abilities of the student as being "classically" normal. The implied state of physical normalcy is portrayed within the pictures illustrating the participating students. The issue is not to criticize the scope of his work, but rather to establish the idea that a physical handicap does not imply a genetic mental or spiritual deficiency. Therefore, the same degree of discipline should also benefit orthopedically handicapped students.

The art teacher working with the severely orthopedically handicapped student is confronted with an interactive communications barrier that not only inhibit the student's ability to express their own identity, but also hinders the teacher's ability to guide the student's interpretation of his or her life environment as could be expressed through pencil drawings. In a noble attempt to circumvent the student's physical handicap, the teacher often "assists" in the physical process of creating a drawing that is intended to reflect the child's unique creative awareness. Unfortunately the process of assisting tends to relegate the intended participant to a vicarious spectator. As a result, the student's unique awareness can never be elevated to the level of individual recognition as long as the student is denied the gratification of total participation.

Resolution of the inhibiting barrier to interactive communications can be accomplished through implementation of the PLATO graphics editor. The graphics editor can provide the student with an ability to participate directly in the creation of electronically produced simulated pencil drawings. Similar to the previously discussed text editor, PLATO's graphics capabilities allows the individual to revise the drawing during or after its completion. If editing is necessary after completion, then a thorough knowledge of the SD option is required. Mastery of this option should not present a problem for the orthopedically handicapped student of average intelligence. A resonable basis for this expectation can be drawn from the Student JPR Program. The Director of the JPR Program supports the contention that the ID and SD options are easily learned by very young students (Kolstad, 1981). The JPR Program is a series of introductory lessons designed to teach anyone the basic elements of TUTOR, the program language for the PLATO System. To access this lesson series, press either the next key on the standard keyboard, or the NEXT switch on the SAU of the PPTI[illegible] system to initiate the terminal. Instead of using your normal PLATO signon, type "student" and press next, then "jpr". After completion of these steps follow instructions contained within the lesson series.

Another feature of PLATO's editing capabilities is the ability to integrate text into the graphic illustration. Use of this option permits the insertion of needed explanatory comments to add clarity to complex illustrations. Combining the graphics and text capabilities of PLATO can aid in sharpening the communicative skills necessary for the clarification of learning, teaching, and the expression of ideas. Since this report was entirely written and illustrated using PLATO's editor, it is offered as primary evidence in support of the claim that "clarification of learning, teaching, and the expression of ideas" can significantly be enhanced with the editor. The editor has enabled the author, who is orthopedically handicapped and is therefore subject to the problems being addressed, to clearly define the interactive communications problem, and then to state the proposed solution using not only standard text but also expanding upon the operation of the PPTK system through the combining of text and graphics.

In order to combine text into graphics press the lower-case "t" for insertion of textual comments into the graphic display. To resume drawing simply press the "BACK" control key of the standard keyboard. If the PPTK is being used than superimpose the keyselector on the "B" control key symbol and then press INPUT.

Text Considerations
Relative Line Positioning

The switches labeled "⇧" and "⇩" allow you to control the screen position of the keyboard display.

When you press one of these switches the PPTK will continue to travel up or down indefinitely until the switch is released. These two switches control the relative line position of the PPTK. The PLATO terminal screen has 32 lines from top to bottom. The PPTK can move to any of the lines.

→+←-÷×Ø123456789= abcdefghijklmnopqrstuvwxyz,./; _SsTEMHOIBL↑DS2

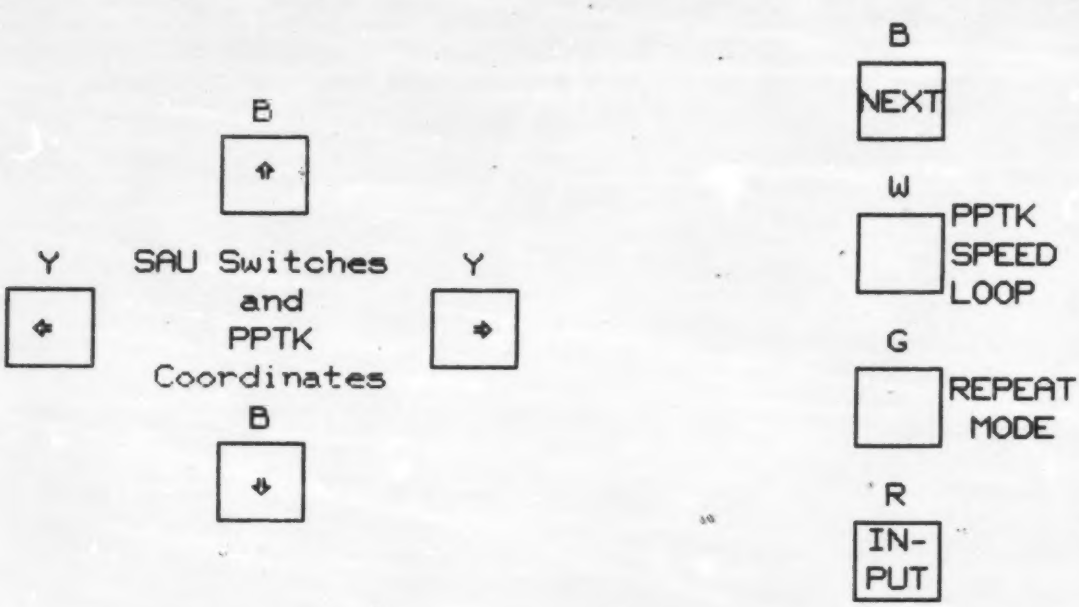
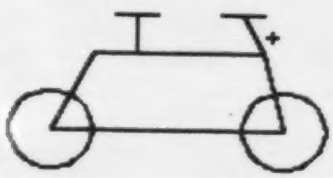


Figure 22.
Line Positioning

→+←-+×Ø123456789= bcdefghijklmnopqrstuvwxyz,./; _SsTEMHOIBL↑DS2

Now the PPTK keyboard is at the top of the screen. By relocating the keyboard display from its initial bottom line position you can accommodate a wide range of spatial screen-display conditions. For example, if the PPTK were not moved from line 32, the keyboard display would obstruct the information illustrated on lines 31 and 32. A careful look at the bottom of this page will clarify the problem.



PLEASE EXCUSE THIS RATHER CRUDE ATTEMPT AT DRAWING A BICYCLE (?) An artist, I am not.

This graphics cursor information would not be visible if the PPTK remained on line 32.

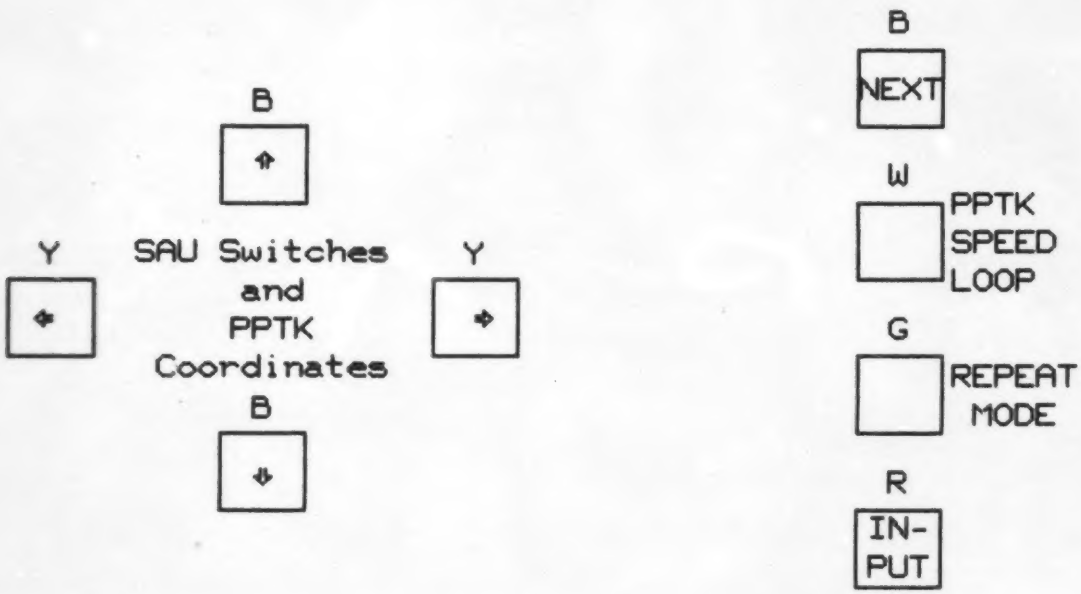
(259,263) = 1633
FINE GRID (315/32Ø)

Figure 23.
PPTK Line Positioning

Wraparound

When the downward key is pressed "⇩", assuming the keyboard line display is on line 32, the PPTK will "wraparound" by instantly jumping from line 32 back to line 1.

By using the wraparound technique, to move from line 32 to line 1 and vice-versa, the PPTK single line display may be moved without causing the screen text to disappear. Screen text vanishes only when the PPTK display actually passes through or over the affected portion of the screen display.



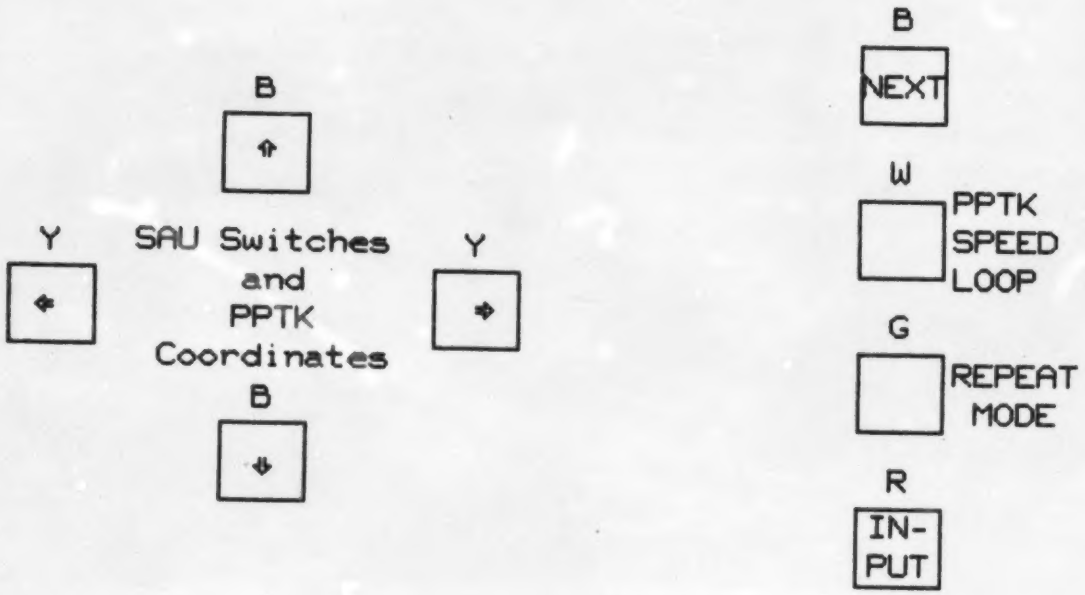
→+◆-+×Ø123456789= bcdefghijklmnopqrstuvwxyz,./; _SsTEMHOIBL↑DS2

Figure 24.
Wraparound Technique

Recovering Screen Text

To recover lost screen text, place the key selector over the BACK function key symbol, press INPUT, reposition the PPTK keyboard display to some other screen location, and press NEXT.

With this procedure it is possible to read all 32 lines of screen text, even though the keyboard display may be constantly occupying one of the 32 lines.

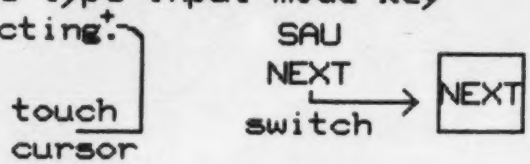


→+←-+×Ø123456789= abcdefghijklmnopqrstuvwxyz,./; _SsTEMHOI[illegible]L↑DS2

Figure 25.
Recovery of Lost Screen Information

There is also another method of recovering screen text. By putting the PPTK system into touch mode the keyboard display disappears instead of the text. The SAU/NEXT switch remains operative in touch mode, facilitating the student's ability to advance from one screen display to another in any instructional lesson.

During intense mental concentration the student may elect to change momentarily from typed input mode to touch input mode. This can be done if the constant blinking of the type input mode key selector becomes distracting.



3

Figure 26.
Additional Uses for the Touch Mode

X. Adaptive Testing

The PPTK technology is intended to promote the intellectual growth of severely orthopedically handicapped individuals who cannot physically cope with the time-honored education or communication technology fundamentally consisting of paper and pencil.

Before the development of the PPTK technology, the administration of standardized tests was logistically not practicable. Having now provided the technology to enable the severely orthopedically handicapped to function independently, physically as well as intellectually, we face still another problem: the inherent problem of bias in testing.

Regardless of how versatile PLATO technology may be, it cannot deliver "good results" from an ill-conceived test. To circumvent the problems associated with bias in the administering of any "standardized" test, the appropriate implementation of Adaptive testing must be considered.

Adaptive testing is not a panacea for the bias ills of established standardized tests, but rather is a promising, recently developed method of delivering "standardized test" information to the examinee.

The Adaptive testing method allows each examinee to take a flexible number of items selected from a larger item pool, creating a unique sub-item pool for each examinee. Performance with this subset of items determines the ability level of the individual examinee (Betz & Weiss, 1975). Thus, each examinee is administered a different set of items, in contrast to the procedure for conventional or standardized testing methods, in which all examinees take an identical set of test items. For the benefit of the examinee, it is essential to select a bias-free item pool for the population being examined (Pine & Weiss, 1979), (Tatsuoka & Birenbaum, 1979).

Adaptive testing can considerably reduce testing time and provide more accurate information than yielded by conventional tests. The typical number of items required range from 10 to 20 items. For standardized tests, 60 to 80 items are required. The advantage of Adaptive testing to orthopedically handicapped examinees is obvious. In other words, the results of a well constructed test will not be adversely affected by physical or mental fatigue.

With implementation of the direct-selection capability of the Touch Input Mode, coupled with PLATO's ability for administering of tests, accurate evaluation of preschool orthopedic children is now possible. For the very young child who may not understand how to use the PPTK for typed input, it is suggested that the testing material be designed so that Touch Input Mode can be used for entering responses. Use of the Touch Input Mode would have the effect of simplifying the keyboard, thus making PLATO intellectually more manageable for the child. Instead of the child being overwhelmed by the 64 characters employed for typed input, he or she would be working with only six switches to indicate his or her response. These six switches would involve: The Next Key, Input switch, and the four Touch Cursor Coordinate switches, which in part make up the switch assembly unit.

The child, who may not even have elementary reading skills, can benefit from PLATO's versatile technology regardless of orthopedic severity.

If help is needed in the construction of tests, the Handicap Technology Program will try to assist.

XI. Concluding Remarks

This report has taken the position that intellectually alert severely orthopedically handicapped children and adults can significantly benefit through the interactive instructional and communications technology of PLATO. The PPTK system and this document have been developed on the premise that orthopedically handicapped children need to be intellectually challenged to reach beyond the present standards of "Special Education".

Educators, parents, and orthopedically handicapped students must release themselves from the crippling effects of a "myopic" perspective. It has always been too easy to justify the physical handicap as a reason for the lack of scholastic achievement. Unfortunately, this compromising perspective can economically isolatate the future adult by making him or her a non-tax-paying welfare dependent. The relationship between economics and education is closely interwoven into the fabric of American tradition. Eveyone respects personal success, particularly if it is externally recognized as a well earned accomplishment of a physically handicapped individual. But for the intellectually alert orthopedically handicapped it is difficult to accept the tragic tendency of human nature that projects a negative notion of apprehensiveness and despair that often leads to economic dependence.

The last issue to be addressed is that of consumer commitment. This remains the most elusive of all issues. It can be addressed only by the affected handicapped student. For those students seriously committed to the premise that higher education is the key to future "success", the Computer-Based Education Research Laboratory within the University of Illinois is willing and able to help any orthopedically handicapped student to earn a quality education while at the Champaign-Urbana campus. A richly diversified educational experience can help you become known by the power of the words you articulate and respected for ideas you express. Also learn to accept your handicap, but never compromise your abilities. The acquisition of a college or university degree certifies only your competency within your chosen area of academic pursuit; therefore, it cannot guarantee your placement into a job. The ultimate responsibility is yours to be assertively positive and creatively persuasive.

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